



Glucocorticoids and Hospital Length of Stay for Children with Anaphylaxis: A Retrospective Study

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Objective To evaluate whether glucocorticoid administration is associated with improved outcomes in children with anaphylaxis.

Study design We included children from the Pediatric Health Information System database who were diagnosed with anaphylaxis at 35 US children's hospitals between 2009 and 2013. Patients were stratified by disposition from the emergency department (ED), either hospitalized or discharged. We evaluated the association between glucocorticoid administration and prolonged length of stay (LOS), defined as hospital stay ≥ 2 days, and subsequent epinephrine administration among hospitalized children. Among discharged children, we assessed the association between glucocorticoid administration and ED revisits within 3 days. Analyses were adjusted for illness severity using ordering of laboratory tests, medications, oxygen, intravenous fluids, and admission to the intensive care unit.

Results Among 5203 children hospitalized with anaphylaxis, 424 (8.2%) had prolonged LOS. Glucocorticoid administration was inversely associated with prolonged LOS (aOR, 0.61; 95% CI, 0.41-0.93) and with subsequent epinephrine use (aOR, 0.63; 95% CI, 0.43-0.84) among hospitalized children. Glucocorticoid administration was not associated with the odds of a 3-day revisit (aOR, 1.01; 95% CI, 0.50-2.05) among discharged patients.

Conclusion The use of glucocorticoids was inversely associated with prolonged LOS among children hospitalized with anaphylaxis, but was not associated with 3-day ED revisits among discharged children. These findings support the use of glucocorticoids in children hospitalized with anaphylaxis. (*J Pediatr* 2015;167:719-24).

The incidence of anaphylaxis has been increasing worldwide, accounting for more than 2800 annual pediatric hospitalizations in the US.¹⁻⁵ Although most cases of anaphylaxis resolve after initial treatment, up to 20% of patients have protracted symptoms or a biphasic reaction, a delayed recrudescence of illness occurring hours after improvement of the initial symptoms.⁶⁻¹³

Glucocorticoids are often used as initial therapy for allergic reactions and anaphylaxis, and are postulated to act as preventive therapy for protracted or biphasic anaphylaxis (PBA).¹⁴⁻¹⁹ Glucocorticoids are increasingly being used in the US and were used in at least one-half of patients evaluated in an emergency department (ED) in 2004.^{14,20} Guidelines in the US, United Kingdom, and Europe recommend glucocorticoids as second-line agents for the treatment of anaphylaxis after the use of epinephrine, and all note the paucity of evidence supporting this recommendation.^{17,19,21} However, even with short courses, the use of glucocorticoids may be associated with adverse effects including mood changes, rebound atopic dermatitis, and osteoporosis.²²⁻²⁴ There are no clinical trials assessing glucocorticoid efficacy for prevention of PBA.^{7,25}

Glucocorticoids are administered to 50-97% of individuals with anaphylaxis, despite a lack of compelling evidence supporting their use.^{7,8,10,11,14,26} This wide variability in usage combined with the paucity of high quality data speak to the need for further studies evaluating whether there is any benefit to glucocorticoid therapy in anaphylaxis. We conducted a retrospective study of more than 10 000 children with anaphylaxis to evaluate whether glucocorticoid administration is associated with prolonged length of stay (LOS), a potential surrogate marker of PBA.

Methods

Patients were drawn from the Pediatric Health Information System (PHIS) database (Children's Hospital Association, Overland Park, Kansas). The PHIS database contains clinical and billing data from 44 not-for-profit, tertiary care children's hospitals. The data collection, validation, and safeguarding procedures are ensured through a joint effort between the Children's Hospital Association and participating hospitals, and have been described previously.²⁷⁻²⁹ We included data

ED	Emergency department
ICU	Intensive care unit
LOS	Length of stay
PBA	Protracted or biphasic anaphylaxis
PHIS	Pediatric Health Information System

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from 35 hospitals with complete data reporting for hospitalized and ED patients. The Institutional Review Board at Boston Children's Hospital approved the study.

We included children aged 1 month to 18 years presenting to an ED with a primary diagnosis of anaphylaxis (*International Classification of Diseases, Ninth Revision* codes 995.0, 995.6, and 995.60-995.69) between January 1, 2009, and September 30, 2013. We excluded children with a previous ED visit within 3 days for a primary or secondary diagnosis of anaphylaxis, as well as those with missing data regarding hospitalization.

Primary Exposure

Patients were considered to have received a glucocorticoid if they received 1 or more doses of dexamethasone, methylprednisolone, prednisolone, or prednisone intravenously or orally on the day of presentation.

Outcomes

The primary outcome among hospitalized patients was prolonged LOS, defined as stay of ≥ 2 days. A secondary outcome among hospitalized children was the use of parenteral epinephrine beyond the first hospital day. Among discharged patients, the outcome was a revisit to the ED for a diagnosis of allergic reaction (All Patient Refined Diagnosis Related Group, version 24 code of 811) within 3 days of the initial visit, regardless of whether or not the second visit resulted in hospitalization.

Covariates

Potential confounders were markers of severity and were determined a priori based on their potential to both influence the decision to use glucocorticoids and to prolong LOS.^{29,30} We included only potential confounders that were highly likely to be determined concurrently with or before the decision to administer glucocorticoids, to avoid inadvertently including mediators or colliders in the model.

Potential confounders included demographic characteristics, such as age, sex, race (white, black, Asian, or other), and insurance status (public, private, or other). We also included asthma codiagnosis, defined as a secondary diagnosis of asthma during their anaphylaxis visit, and history of asthma, defined as a visit in the previous 24 months with an associated asthma diagnosis code (*International Classification of Diseases, Ninth Revision* code 493.xx).³¹ Patients were also classified based on the presence of a complex chronic condition using a previously reported classification method.³² To account for differences in illness severity, we also adjusted our analysis for the use of medications administered during the initial hospital day, including bronchodilators (albuterol, levalbuterol, or salbutamol), inhaled epinephrine or racepinephrine, parenteral epinephrine, H1 blockers (diphenhydramine, cetirizine, or hydroxyzine), H2 blockers (ranitidine, cimetidine, nizatadine, or famotidine), and administration of intravenous fluids.^{10,17,29,30}

We also adjusted our analysis for other markers of severity, including performance of a venous or arterial blood gas analysis, chemistry profile, intubation, central venous cannulation, or admission to an intensive care unit (ICU).³³

The screen for confounders was performed separately for hospitalized and discharged children, resulting in a different list of variables for inclusion in multivariate models.

Statistical Analyses

Multivariate logistic regression was used to assess the association between glucocorticoid use and prolonged LOS, adjusting for covariates identified as potential confounders that were associated with glucocorticoid administration on univariate testing ($P < .20$). Because our data were abstracted from several hospitals, the assumption of independent observations might not hold. To accommodate these data, our regression model used clustered sandwich SE estimates, which allow for intrahospital correlation, relaxing the assumption that observations from the same hospital are independent.

To assess for the impact of possible prehospital glucocorticoid administration, we repeated the analysis after excluding patients transferred to the PHIS participating institution. We also repeated the analysis after excluding patients admitted to an ICU, to evaluate a subpopulation of children with nonsevere anaphylaxis.

We evaluated the association between glucocorticoid administration and use of parenteral epinephrine after the first hospital day, adjusting for the same covariates. We then restricted the analysis to the subgroup of patients who had received epinephrine on the first hospital day. We also evaluated the association between glucocorticoid administration and the odds of an ED revisit within 3 days among discharged patients.

Finally, we repeated all analyses by excluding medications and interventions that could mediate the association between glucocorticoid administration and prolonged LOS (for hospitalized children) or 3-day ED revisits (for discharged children).

Hospital-Level Analyses. At the hospital level, we assessed the association between the proportion of hospitalized patients receiving glucocorticoids and prolonged LOS using the Spearman rank correlation coefficient. All statistical tests were 2-sided and performed using Stata 13.1 (StataCorp, College Station, Texas), and the α level was set at 0.05.

Prolonged LOS as a Measure of PBA. We reviewed the electronic medical record at our institution to evaluate the extent to which prolonged LOS represented PBA (defined in the medical record audit by any persistent skin/mucosal, gastrointestinal, respiratory, or cardiovascular symptoms lasting longer than 6 hours from presentation, or evidence of any worsening of allergic symptoms after initial improvement).⁹

Documentation of Epinephrine Administration.

Recognizing that parenteral epinephrine is often administered before hospital arrival in patients with anaphylaxis, we also ascertained whether patients without documented receipt of this medication in the PHIS database had documentation in the electronic medical record of receipt of the medication before ED arrival.¹⁵

Results

Over the 4-year study period, a total of 10 442 patients had a diagnosis code for anaphylaxis. We excluded 96 patients (0.9%) because of a previous ED visit within 3 days for anaphylaxis and 91 patients (0.9%) for missing data (all for unknown hospitalization status). Of the 10 255 patients included in the study, 5203 (50.7%) were hospitalized and 5052 (49.3%) were discharged. Demographic characteristics of the study population are presented in [Table I](#).

Association between Glucocorticoid Use and Prolonged LOS

Of the 5203 hospitalized patients, 424 (8.2%) had prolonged LOS. After adjusting for clinically important covariates ([Table II](#)), children receiving glucocorticoids were less likely than those who did not receive glucocorticoids to have prolonged LOS (aOR, 0.61; 95% CI, 0.41-0.93) ([Table II](#)). Prolonged LOS also was associated with increasing age, the presence of a complex chronic condition, a previous diagnosis of asthma, bronchodilator use, oxygen use, and ICU admission.

The association between glucocorticoid use and prolonged LOS did not change materially after exclusion of patients hospitalized in the ICU (aOR, 0.62; 95% CI, 0.42-0.94), or after exclusion of patients transferred from another hospital (aOR, 0.60; 95% CI, 0.40-0.90).

Of the 5203 hospitalized patients, 422 (8.1%) received epinephrine beyond the first hospital day. Glucocorticoid administration was associated with lower odds of epinephrine administration beyond the first hospital day (aOR, 0.63; 95% CI, 0.43-0.84) ([Table II](#)). Among the 2616 patients given epinephrine on the first hospital day, 204 (7.8%) received a subsequent dose of epinephrine; glucocorticoid use was associated with a reduction in subsequent epinephrine administration (aOR, 0.59; 95% CI, 0.36-0.98).

Among the 5052 discharged patients, 249 (4.9%) had a revisit to the ED within 3 days. Glucocorticoid use was not associated with 3-day ED revisits among discharged patients (unadjusted OR, 1.19; 95% CI, 0.49-2.90; aOR, 1.01; 95% CI, 0.50-2.05) ([Table III](#); available at www.jpeds.com). There remained no association between glucocorticoid use and ED revisits after exclusion of children transferred from another institution (aOR, 1.00; 95% CI, 0.49-2.03). ED revisits were associated with the use of bronchodilators and oxygen, and were lower among blacks and Asians compared with whites.

The associations between glucocorticoid administration and prolonged LOS (aOR, 0.64; 95% CI, 0.43-0.95) and 3-day ED revisit (aOR, 0.93; 95% CI, 0.49-1.78) did not differ from the main findings after restricting our covariates to those present at the time of glucocorticoid administration ([Tables IV](#) and [V](#); available at www.jpeds.com).

Hospital-Level Analyses

Among the 35 hospitals, the median rate of glucocorticoid administration was 77.5% (IQR, 69.0%-85.5%), and the median rate of hospitalization was 40.7% (IQR, 29.3%-65.9%). Glucocorticoid administration at the hospital level was not associated with prolonged LOS (Spearman $\rho = 0.14$; $P = .44$) ([Figure](#); available at www.jpeds.com).

Prolonged LOS as a Measure of PBA. PBA occurred in 24 of 28 patients with prolonged LOS (85.7%; 95% CI, 71.9%-99.5%), compared with only 34 of 410 without prolonged LOS (8.9%; 95% CI, 6.4%-12.2%).

Documentation of Epinephrine Administration. Of the 754 patients at our study institution, 580 (76.9%; 95% CI, 73.8%-79.8%) had documented receipt of epinephrine before arrival or during the ED visit.

Discussion

Among children hospitalized for anaphylaxis, early glucocorticoid administration was associated with a lower rate of hospitalization for 2 or more days. Similarly, children who received glucocorticoids were less likely to receive epinephrine beyond the first hospital day. Glucocorticoids were not associated with a lower rate of ED revisits in children discharged with anaphylaxis. Our findings support national and international guidelines recommending the use of glucocorticoids for children hospitalized with anaphylaxis.^{17-19,21}

Our observation that glucocorticoid use was associated with a reduction in prolonged LOS among hospitalized children only after adjustment warrants further consideration. It is possible that glucocorticoid use reduces LOS, but that other factors are obscuring this relation at the hospital level. It is also possible that glucocorticoid use does not reduce LOS, and that the relation observed may be related to overadjustment. Glucocorticoid use was not associated with a reduction in 3-day ED revisits among children discharged from the ED. The different findings for discharged and hospitalized children may be related to differences in glucocorticoid effectiveness based on illness severity, our selection of outcomes, or unmeasured confounders.

Glucocorticoids act in the mast cell nucleus and down-regulate transcription of proinflammatory cytokines, directly regulate multiple signaling and adaptor molecules, and also rapidly decrease histamine release on the cell surface.³⁴ Therefore, they would be expected to have

Table I. Demographic data for study subjects based on receipt of glucocorticoids on first hospital day, stratified by disposition from the ED (hospitalized vs discharged)

Variables	Hospitalized			Discharged		
	No glucocorticoid (n = 1252)	Glucocorticoid (n = 3951)	P value*	No glucocorticoid (n = 1679)	Glucocorticoid (n = 3373)	P value*
Age, y, median (IQR)	5.9 (2.4-12.0)	6.1 (2.6-12.2)	.14	5.8 (2.5-12.0)	6.0 (2.7-11.7)	.35
Male sex, n (%)	707 (56.5)	2279 (57.7)	.46	903 (53.8)	1983 (58.8)	<.01
Race, n (%)			.03			.02
White	600 (51.9)	1802 (48.0)		768 (48.3)	1636 (50.8)	
Black	350 (30.3)	1265 (33.7)		568 (35.7)	1022 (31.7)	
Asian	56 (4.8)	230 (6.1)		75 (4.7)	192 (6.0)	
Other	151 (13.1)	455 (12.1)		180 (11.3)	372 (11.6)	
Insurance type, n (%)			.97			<.01
Private	650 (54.4)	2078 (53.8)		833 (50.3)	1818 (54.7)	
Public	490 (39.6)	1573 (40.1)		663 (40.0)	1171 (35.2)	
Other	71 (6.0)	235 (6.1)		161 (9.7)	337 (10.1)	
Complex chronic condition, n (%) [†]	98 (7.8)	239 (6.1)	.03	26 (1.6)	40 (1.2)	.29
Anaphylaxis cause, n (%)			.29			<.01
Peanuts	246 (19.7)	816 (20.7)		360 (21.4)	804 (23.8)	
Tree nuts	166 (13.3)	564 (14.3)		168 (10.0)	455 (13.5)	
Fish	61 (4.9)	167 (4.2)		95 (5.7)	166 (4.9)	
Milk	59 (4.7)	175 (4.4)		43 (2.6)	118 (3.5)	
Eggs	36 (2.9)	143 (3.6)		58 (3.5)	106 (3.1)	
Crustaceans	24 (1.9)	88 (2.2)		37 (2.2)	71 (2.1)	
Fruit or vegetable	24 (1.9)	69 (1.8)		39 (2.3)	66 (2.0)	
Food additive	3 (0.2)	15 (0.4)		5 (0.3)	11 (0.3)	
Other specified food	128 (10.2)	476 (12.1)		180 (10.7)	286 (8.5)	
Unspecified food	109 (8.7)	325 (8.2)		142 (8.5)	294 (8.7)	
Other trigger	396 (31.6)	1113 (28.1)		552 (32.9)	996 (29.5)	
Asthma diagnosis, n (%)						
Asthma codiagnosis at current visit	317 (25.3)	1110 (28.1)	.06	123 (7.3)	344 (10.2)	<.01
History of asthma	164 (13.1)	690 (17.5)	<.01	230 (13.7)	522 (15.5)	.10
Laboratory testing, n (%)						
Blood gas analysis	36 (2.9)	118 (3.0)	.84	5 (0.3)	10 (0.3)	.99
Chemistry panel	72 (5.8)	235 (6.0)	.80	11 (0.7)	29 (0.9)	.44
Medications, n (%)						
Bronchodilator	147 (11.7)	1307 (33.1)	<.01	104 (6.2)	664 (19.7)	<.01
Epinephrine, inhaled	13 (1.0)	175 (4.4)	<.01	6 (0.4)	64 (1.9)	<.01
Epinephrine, parenteral	254 (20.3)	2362 (59.8)	<.01	295 (17.6)	1600 (47.4)	<.01
H1 blocker	515 (41.1)	3129 (79.2)	<.01	569 (33.9)	2013 (59.7)	<.01
H2 blocker	432 (34.5)	3038 (76.9)	<.01	256 (15.3)	1701 (50.4)	<.01
Glucocorticoid						
Prednisone		374 (9.5)			531 (15.7)	
Prednisolone		1085 (27.5)			1439 (42.7)	
Methylprednisolone		1794 (45.4)			910 (27.0)	
Dexamethasone		179 (4.5)			391 (11.6)	
Multiple types		519 (13.1)			102 (3.0)	
Therapies, n (%)						
Oxygen	51 (4.1)	209 (5.3)	.09	13 (0.8)	31 (0.9)	.60
Intravenous access [‡]	294 (23.5)	1572 (39.8)	<.01	106 (6.3)	776 (23.0)	<.01
Central venous catheter	1 (0.1)	3 (0.1)	.97	0	0	
Intubation and/or positive pressure ventilation	7 (0.6)	33 (0.8)	.33	1 (0.1)	0	
Transferred from another hospital, n (%)	118 (9.4)	116 (2.9)	<.01	29 (1.7)	10 (0.3)	<.01
Admission to an ICU, n (%)	43 (3.4)	176 (4.5)	.12	0	0	

Some variables do not add up to 100% owing to missing data.

*Using the Mann-Whitney rank-sum test for comparing continuous variables and the χ^2 test for comparing categorical variables.

†Complex chronic condition defined by *International Classification of Diseases, Ninth Revision* discharge diagnosis codes.³²

‡Includes patients who underwent peripheral intravenous cannulation or received intravenous fluids.

clinically immediate and late effects such as those observed in asthma, supporting the biological plausibility of using glucocorticoids to prevent PBA in children with anaphylaxis.

International guidelines differ regarding the role of glucocorticoids in anaphylaxis. Published guidelines in the US, UK, and Europe recommend glucocorticoids as second-line adjunctive therapy, but all mention the lack of robust evidence supporting their use.^{17,19,21} In contrast,

Australian guidelines do not recommend the use of glucocorticoids, likely owing to the same paucity of data.¹⁶

Previous pediatric studies have reported PBA rates of 7%, 13%, and 5% with different inclusion criteria and definitions of biphasic reactions.^{9,10,12} Nevertheless, those rates are similar to our rates of 8.2% for prolonged LOS and 8.1% for epinephrine beyond the first hospital day. Two previous pediatric studies found no association between glucocorticoid administration and biphasic reactions; however, those

Table II. Unadjusted ORs and aORs with 95% CIs for prolonged LOS (≥ 2 days) among hospitalized patients and for epinephrine given after the first hospital day

Predictors	Odds of prolonged LOS		Odds of epinephrine administration*	
	Unadjusted OR (95% CI)	aOR [†] (95% CI)	Unadjusted OR (95% CI)	aOR [†] (95% CI)
Glucocorticoid	0.75 (0.51-1.10)	0.61 (0.41-0.93)	0.45 (0.28-0.71)	0.63 (0.48-0.84)
Age (years)	1.08 (1.05-1.11)	1.06 (1.03-1.10)	1.01 (0.98-1.03)	1.00 (0.97-1.02)
Race				
White	Referent	Referent	Referent	Referent
Black	0.88 (0.52-1.49)	0.93 (0.55-1.57)	0.88 (0.64-1.21)	0.93 (0.66-1.31)
Asian	0.42 (0.22-0.79)	0.49 (0.21-1.15)	0.83 (0.36-1.94)	0.92 (0.36-2.30)
Other	0.77 (0.48-1.23)	0.86 (0.46-1.60)	0.62 (0.43-0.91)	0.70 (0.47-1.04)
Complex chronic condition [‡]	4.59 (3.29-6.40)	2.98 (2.11-4.22)	1.73 (1.14-2.63)	1.34 (0.82-2.18)
Asthma diagnosis				
Asthma codiagnosis at current visit	1.54 (1.13-2.08)	1.05 (0.78-1.42)	1.15 (0.90-1.48)	1.16 (0.93-1.44)
History of asthma	1.60 (1.20-2.14)	1.56 (1.19-2.05)	1.03 (0.72-1.48)	1.09 (0.71-1.67)
Medications				
Bronchodilator	1.74 (1.33-2.29)	1.32 (1.02-1.70)	0.80 (0.56-1.14)	0.84 (0.65-1.10)
Epinephrine, inhaled	2.52 (1.44-4.41)	1.07 (0.56-2.03)	1.37 (0.83-2.25)	1.18 (0.78-1.80)
Epinephrine, parenteral [§]	1.40 (1.05-1.89)	1.21 (0.87-1.67)	0.92 (0.62-1.37)	1.34 (0.94-1.91)
H1 blocker	1.03 (0.80-1.32)	1.04 (0.79-1.36)	0.41 (0.30-0.55)	0.48 (0.37-0.60)
H2 blocker	0.89 (0.62-1.29)	0.71 (0.49-1.04)	0.49 (0.31-0.78)	0.61 (0.42-0.88)
Therapies				
Oxygen	6.46 (3.70-11.3)	2.52 (1.48-4.31)	2.93 (1.72-4.97)	2.47 (1.42-4.30)
Intravenous access [¶]	1.87 (1.41-2.48)	1.28 (0.98-1.68)	1.13 (0.84-1.51)	1.29 (0.88-1.89)
Admission to an ICU	22.3 (14.6-34.1)	13.4 (8.79-20.5)	2.97 (1.89-4.66)	2.19 (1.39-3.46)

All variables shown were included in the adjusted models.

*Odds of parenteral epinephrine administration after the first hospital day.

†Predictors associated with glucocorticoid use on the first day of hospitalization (with $P < .20$) were included.

‡Complex chronic condition defined by *International Classification of Diseases, Ninth Revision* discharge diagnosis codes.³²

§Parenteral epinephrine administered on the first hospital day.

¶Includes patients who underwent peripheral intravenous cannulation or received intravenous fluids.

observations were based on a small number of patients with biphasic reactions (6 in one study and 12 in the other).^{9,10}

PBA occurs infrequently in adults with anaphylaxis, with a prevalence ranging from 0 to 20%.^{6-8,11,12} Few studies have evaluated the association between glucocorticoid use and anaphylaxis in adults. In one Canadian ED, 55% of patients with uniphasic anaphylaxis and 35% of those with biphasic anaphylaxis received glucocorticoids, a difference that did not achieve statistical significance.⁷ Another study observed that fewer patients with biphasic reactions received glucocorticoids compared with patients with uniphasic reactions (84% vs 98%), an association concordant with the findings in the present study.¹¹

We observed marked variation in the use of glucocorticoids in pediatric hospitals for children presenting to the ED with anaphylaxis, despite published guidelines recommending their use. Although the prevalence of anaphylaxis is higher in latitudes further from the Equator, other regional severity differences have not been described.³⁵⁻³⁷ Regional and local variations in epidemiology, locally different practice patterns, and variable adherence to guidelines may explain some of the variation in the use of glucocorticoids for anaphylaxis in the US.

This study has several limitations. First, we acknowledge that our a priori definition of hospital LOS ≥ 2 days might not be the ideal measure of PBA; however, only limited data are available in the PHIS database to assess for this clinically important outcome. In support of our case definition, our internal review of patients with anaphylaxis

at our own institution demonstrated that a majority of children with hospital LOS ≥ 2 days had PBA, and that most children with shorter duration of hospitalization did not. In addition, our proportion of patients with LOS ≥ 2 days (8.1%) is similar to the rate of biphasic anaphylaxis reported in other studies.⁷⁻¹³ We did not limit our analysis to children who received epinephrine in the hospital setting, and as such, might have falsely classified some patients as having anaphylaxis. However, our single-center medical record audit suggests that most children with a primary diagnosis of anaphylaxis who do not receive epinephrine in the hospital actually receive the medication in the prehospital setting.¹⁵ Given our differing results in hospitalized children and discharged children, our findings may have limited applicability when the disposition of a patient is not known. As with other studies relying on the use of administrative and retrospective data, our study is subject to biases relating to inaccuracies in case ascertainment, data quality, and lack of detailed clinical information. Finally, we cannot evaluate how physician preference or experience affected the rate of glucocorticoid use in the children included in our study.

Although we could not determine whether glucocorticoids were administered before ED arrival, a previous pediatric multicenter study found that only 8% of children with anaphylaxis received this medication before arrival at the ED.¹⁵ In addition, although we could not ascertain glucocorticoid administration for children transferred from other healthcare settings to a PHIS participant institution, exclusion of transferred patients did not affect our findings.

Wide variation exists in the use of glucocorticoids for children with anaphylaxis. We found an inverse association between early glucocorticoid administration and hospitalization for 2 or more days, as well as with subsequent epinephrine use during hospitalization. There was no association between glucocorticoid administration and 3-day ED revisits among children discharged from the hospital with anaphylaxis. This study supports national guidelines recommending the use of glucocorticoids in children with anaphylaxis.¹⁷ ■

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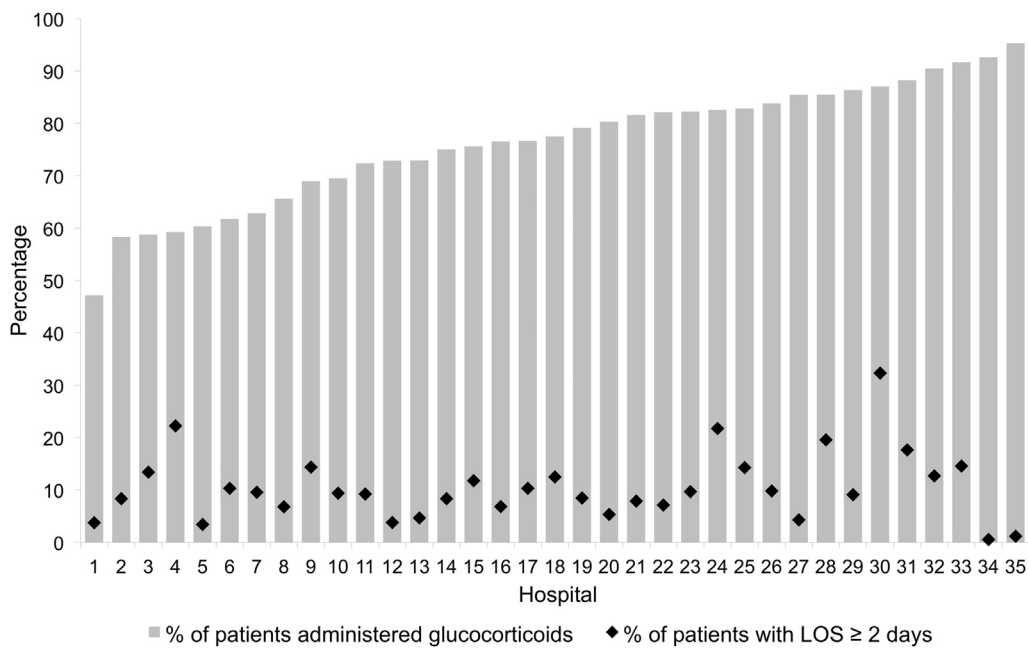


Figure. Percentage of hospitalized patients who received glucocorticoids on the first day of hospitalization, and percentage of patients with prolonged LOS at each of the 35 participating hospitals.

Table III. Unadjusted and adjusted odds of ED revisit within 3 days

Predictors	Unadjusted OR (95% CI)	aOR* (95% CI)
Glucocorticoid	1.19 (0.49-2.90)	1.01 (0.50-2.05)
Male sex	1.01 (0.60-1.71)	0.96 (0.60-1.53)
Race		
White	Referent	Referent
Black	0.56 (0.36-0.89)	0.57 (0.36-0.89)
Asian	0.34 (0.16-0.75)	0.32 (0.16-0.63)
Other	0.56 (0.29-1.07)	0.59 (0.28-1.21)
Insurance status		
Private	Referent	Referent
Public	0.55 (0.23-1.34)	0.61 (0.22-1.72)
Other	0.52 (0.17-1.60)	0.60 (0.22-1.62)
Asthma diagnosis		
Asthma codiagnosis at current visit	1.39 (0.65-2.96)	1.41 (0.50-4.01)
History of asthma	1.19 (0.82-1.75)	1.29 (0.82-2.01)
Anaphylaxis cause		
Peanuts	Referent	Referent
Tree nuts	1.32 (0.84-2.10)	1.23 (0.74-2.04)
Fish	0.99 (0.36-2.73)	0.86 (0.44-1.68)
Milk	0.26 (0.02-3.05)	0.24 (0.02-2.78)
Eggs	1.05 (0.60-1.85)	1.06 (0.52-2.13)
Crustaceans	1.20 (0.46-3.18)	1.65 (0.68-3.98)
Fruit or vegetable	0.82 (0.28-2.35)	1.14 (0.38-3.45)
Food additive [†]	1 (omitted)	1 (omitted)
Other specified food	0.74 (0.37-1.46)	0.68 (0.37-1.23)
Unspecified food	1.09 (0.35-3.41)	1.26 (0.55-2.87)
Other trigger	1.15 (0.51-2.59)	1.09 (0.57-2.08)
Medications		
Bronchodilator	2.12 (1.20-3.74)	1.76 (1.18-2.63)
Epinephrine, inhaled	2.50 (0.97-6.41)	2.40 (0.89-6.43)
Epinephrine, parenteral	2.14 (0.77-5.96)	2.21 (0.80-6.12)
H1 blocker	1.39 (0.75-2.59)	1.34 (0.85-2.12)
H2 blocker	0.53 (0.18-1.55)	0.42 (0.12-1.47)
Therapies		
Oxygen	5.36 (1.52-18.9)	3.71 (1.65-8.34)
Intravenous access [‡]	0.87 (0.43-1.76)	0.80 (0.36-1.81)

All variables listed in the Table were included in the adjusted model.

*Predictors associated with glucocorticoid use on the day of ED visit (with $P < .20$) were included.

†All 16 patients whose anaphylaxis was due to a food additive did not revisit the ED within 3 days, and thus these patients were excluded from the model.

‡Includes patients who underwent peripheral intravenous cannulation or received intravenous fluids.

Table IV. aORs with 95% CIs for prolonged LOS (≥ 2 days) among hospitalized patients and for epinephrine given after the first hospital day

Predictors	Odds of prolonged LOS, aOR (95% CI)	Odds of epinephrine administration,* aOR (95% CI)
Glucocorticoid	0.64 (0.43-0.95)	0.41 (0.27-0.63)
Age (years)	1.07 (1.04-1.10)	1.00 (0.98-1.02)
Race		
White	Referent	Referent
Black	0.73 (0.44-1.21)	0.86 (0.60-1.23)
Asian	0.50 (0.26-0.96)	0.90 (0.38-2.12)
Other	0.78 (0.48-1.29)	0.62 (0.42-0.90)
Complex chronic condition [†]	4.23 (3.03-5.88)	1.67 (1.11-2.50)
Asthma diagnosis		
Asthma codiagnosis at current visit	1.29 (0.96-1.75)	1.21 (0.96-1.51)
History of asthma	1.48 (1.17-1.87)	1.07 (0.71-1.60)
Epinephrine, parenteral [‡]	1.54 (1.16-2.04)	1.22 (0.84-1.79)

Analyses were limited to patient demographics and parental epinephrine administration, to avoid inclusion of potential mediators in the models.

*Odds of parenteral epinephrine administration after the first hospital day.

†Complex chronic condition defined by *International Classification of Diseases, Ninth Revision* discharge diagnosis codes.³²

‡Parenteral epinephrine administered on the first hospital day.

Table V. Adjusted odds of ED revisit within 3 days

Predictors	aOR (95% CI)
Glucocorticoid	0.93 (0.49-1.78)
Male sex	0.96 (0.60-1.55)
Race	
White	Referent
Black	0.58 (0.37-0.92)
Asian	0.33 (0.16-0.66)
Other	0.62 (0.30-1.28)
Insurance status	
Private	Referent
Public	0.63 (0.24-1.69)
Other	0.49 (0.14-1.70)
Asthma diagnosis	
Asthma codiagnosis at current visit	1.45 (0.52-4.05)
History of asthma	1.32 (0.82-2.12)
Anaphylaxis cause	
Peanuts	Referent
Tree nuts	1.21 (0.74-1.99)
Fish	0.86 (0.45-1.65)
Milk	0.25 (0.02-3.03)
Eggs	1.07 (0.58-1.98)
Crustaceans	1.66 (0.73-3.80)
Fruit or vegetable	0.99 (0.34-2.85)
Food additive*	1 (omitted)
Other specified food	0.69 (0.38-1.24)
Unspecified food	1.19 (0.44-3.21)
Other trigger	1.08 (0.53-2.21)
Epinephrine, parenteral	2.26 (0.84-6.06)

Analyses were limited to patient demographics and parental epinephrine administration, to avoid inclusion of mediators in the model.

*All 16 patients whose anaphylaxis was due to a food additive did not revisit the ED within 3 days, and thus these patients were excluded from the model.